

Chapter 4 Highway Lighting

Highway Illumination...section 807

This work shall consist of installing wire, cable, conduit, lighting standards, luminaires, lamps, and incidental materials in accordance with these specifications and in reasonably close conformance with the lines, grades, and locations shown on the plans or as directed.

Lighting installations shall be in accordance with the National Electrical Code and the National Safety Code.

Maintenance of Highway Illumination. Existing highway illumination shall be maintained on all projects unless discontinuance of the highway illumination is specifically permitted.

Manufacturers' descriptive and technical literature for major items shall be submitted for approval. Where it is normal trade practice to furnish a warranty, a warranty shall be furnished on all major items such as luminaires, lamps, poles, brackets, cable-duct, wire and cable, fuse connectors, and ballasts. The effective date of the warranty shall commence on the date of final acceptance. These items shall bear the seal of approval of the UL.

All flexible conduit shall be galvanized steel, polyvinyl jacketed, and watertight.

Reinforcing steel shall be epoxy coated.

CONSTRUCTION REQUIREMENTS

Excavation. All excavation for the roadway lighting installation shall be performed in accordance with the dimensions, elevations, and grades shown on the plans or as directed. If class X material is encountered, foundation excavation shall be completed in accordance with 206.

Trench Excavation. Excavation may be accomplished either manually or with mechanical trenching equipment. The blades of road patrols or graders shall not be used to excavate the trenches. The depth of trenches shall be a minimum of 2 ft. Walls of trenches for cable-duct or conduit shall be essentially vertical. The bottoms of trenches shall be smooth and free from aggregate larger than

1/2 in. Bracing, shoring, and sheathing shall be provided as necessary. If the excavation, through accident or otherwise, is below the required level. The excess excavated area shall be refilled in a satisfactory manner with no additional payment. The accumulation of water in excavated areas shall be prevented by the use of pumps or other approved means. When rocks or other materials which might damage the cable- duct or conduit are encountered, the excavation shall be extended to a depth of at least 27 in. and backfilled with a 3 in. compacted layer of sand or earth containing no particles that would be retained on a 1/4 in. sieve. No extra payment will be made for this additional excavation or backfill.

Foundation Excavation. If possible, excavation for concrete foundations shall be accomplished by means of drilling with an auger of sufficient size to admit the width of the foundation. Work shall be so scheduled that all open excavations are poured with concrete during the workday they are dug. No excavations shall remain open over night or over a weekend or holiday. Accumulated water shall be removed from the excavation before concrete is poured. If class X material is encountered, foundation excavation shall be completed in accordance with 206.02(b).

Landscape Replacement. Where roadside shrub plantings interfere with the location of illumination installations, the plantings shall be reset at other locations and at such times as directed, all in accordance with 622. The cost of this work will not be paid for directly, but shall be included in the costs of other pay items.

All slopes for foundation grading shall be sodded. Sod shall be placed in accordance with 621.

Backfilling. Wherever practicable, all suitable materials removed from the excavated areas shall be used in refilling cable-duct and conduit trenches. No excavated materials shall be wasted without authorization. Materials authorized to be wasted shall be disposed of as approved. Backfill for trenches shall be placed in layers not to exceed 6 in., loose measurement. The first layer shall be sand or earth containing no particles or lumps that would be retained on a 1/4 in. sieve. The second layer shall contain no particles or lumps that would be retained on a 1 in. sieve. Subsequent layers shall contain no particles or lumps that would be retained on a 3 in. sieve. The second layer and each subsequent layer shall be compacted with pneumatic hand tamps to the satisfaction of the Engineer to prevent any future settlement of the backfilled area. Backfilling of cable-duct and conduit trenches around lighting standard foundations, handholes, manholes, and other structures shall be in accordance with the applicable provisions of 211. Finish grading of earthwork shall be accomplished in a satisfactory manner.

Placing Conduit. Conduit shall be placed as shown on the plans and in accordance with applicable provisions of 805.11. Conduit shall be of a size to readily permit the passage of the cable-duct being used.

Conduit installed under pavement shall extend a minimum of 2 ft beyond the edge of the paved surface or improved shoulder. The ends of such conduit shall terminate a nominal 2 ft below the ground surface. The ends shall be pitched so as to provide a positive drain to the surrounding soil. The ends shall be protected by threaded cap fittings until the time of installation of cable or cable-duct. Threaded bushing fittings shall be used on all ends before cable installation.

Conduits installed in bridge railing concrete sections shall terminate a minimum of 2 ft beyond the end of the bridge railing outside of the paved surface and a minimum of 2 ft under the ground surface. Existing conduit shall be extended as necessary to satisfy these requirements.

Hot-dipped galvanized, malleable pipe straps and spacers shall be used to attach conduit to bridge structures. Galvanized steel conduit hangers or pipe clamps will not be permitted. Pipe straps of the proper size shall be installed 4 ft center to center along the conduit. When fastening pipe straps to concrete, a 3/8 in. by 2 1/2 in. galvanized steel lag screw, with an approved sleeve, shall be used; however, other approved expansion anchors may be used. The pipe strap and spacer shall be bolted to the steel beams.

Conduit for service supply shall be mounted on a service pole, either company or State owned, near the right-of-way line. For simple supply circuits, one straight, continuous, conduit riser shall be used. The top end shall terminate with a weatherhead device, and the lower end shall terminate at least 2 ft below ground level with a threaded grounding bushing fitting. Unless otherwise directed, the weatherhead shall be 24 ft above the ground. However, the actual elevation of the weatherhead shall meet the requirements of the utility concerned.

Connections in Base of Lighting Standards. Conductors shall be electrically bonded to each other, as required to satisfy circuit requirements, by means of compression type fittings of the style and type shown on the plans. Inhibitor compound shall be used on each compression connection. Conductor identification shall be maintained by connecting like color connectors.

A multiple conductor compression fitting shall be used to connect supply conductors and an insulating link used to provide an extension as shown on the plans. These fittings shall be covered with snap-on fiber or plastic covers designed to protect them from electrical contact. Taping will not be permitted. The bare extension of the supply conductor from the multiple fitting to the insulation link shall be no longer than necessary to admit the application of the snap-on cover for the multiple fitting.

The pole circuits shall be connected by means of easily separated, single conductor connector kits. The connector kit on the "hot" side of the pole circuit shall be fused. The connector kit for the neutral side shall not be fused. Fuses shall be of the "KTK" series with a rated capacity three times the operating amperage of the luminaire. If the required capacity is not a standard size, the next larger size fuse shall be used.

The connector kit on the "hot" side of the pole circuit shall have the following features:

- 1) a line side and load side housing made of plastic or water resisting synthetic rubber suitable for direct burial in the ground or installation in sunlight
- 2) a water seal between the two housings
- 3) each housing permanently marked "Line Side" or "Load Side"

- 4) a spring loaded, 90 % minimum conductivity, contact suitable for gripping the "KTK" cartridge fuse in each housing. These contacts shall be fully annealed
- 5) an interior arrangement for each housing that will adequately receive and rigidly maintain the fuse contacts
- 6) a terminal on each housing designed for a crimp type connection to the conductor that securely retains the conductor in the proper position
- 7) a water seal between the conductor and the housing
- 8) a disconnecting means that shall retain the fuse on the load side when disconnected and keep the conductive parts of the line side inaccessible
- 9) sufficient silicone compound provided and used to lubricate the metal parts and the rubber housings or boots for easy assembly

The neutral side connector kit shall be similar in all respects to that described for the hot side except that a dummy fuse shall be used for the purpose of completing the electrical circuit. The bayonet disconnect feature of the connector kits shall be part of the load side of both the neutral side and the hot side conductors. The line side shall have a socket to receive the bayonet. These kits shall be installed in the pole circuit between the luminaire terminals and the compression connection to the underground distribution circuit as shown on the plans. A separate insulated conductor shall be used to connect the neutral of the underground distribution circuit and the neutral of the pole circuit to the ground lug in the pole base from the point at which both neutrals are connected together by a compression connection. The bayonet disconnect features from the neutral side and the hot side connector kits as cited above shall be included in the sign structure circuitry when luminaires are installed on the sign structures. Consecutive roadway luminaires in a circuit shall be alternately connected to opposite load conductors R or B as specified in the plans to balance the load. Sign luminaires on individual structures shall be similarly connected.

Placing Wire and Cable

Underground Through Cable-duct. All underground distribution conductors shall be continuous runs between splice points. Unless otherwise authorized, splice points shall be inside the bases of lighting standards, inside handholes, in service distribution boxes, at point of connection to power supply in switch boxes, or in junction boxes. All splices shall be made with the proper connector in accordance with 807.06.

Cable-duct. Cable-duct shall be placed either in a trench or plowed into place. Cable-duct shall be installed without sharp bends or kinks and in straight runs so as to permit withdrawal of a conductor and the installation of a new conductor without additional excavation or backfill.

Plowed cable-duct shall be installed at a minimum depth of 2 ft in a single cavity gored into the earth by a vibrating plow blade. The equipment used for plowing the cable-duct shall be designed specifically for that purpose with the power and versatility to easily and accurately bury the various sizes of cable-duct under all normal soil conditions. This equipment shall place the cable-duct without twisting, kinking, or damaging it in any way. Dragging or pulling the cable-duct from the start of the trenching operation will not be permitted. Where two ducts are to be installed parallel to each other, the distance between them shall be no less than 12 in. nor more than 24 in.

The plastic duct of the cable-duct shall be terminated 4 in. above the top of foundations or 4 in. inside handholes with sufficient excess conductors as directed. All terminations of this plastic duct shall be beveled free from any sharp edges or burrs. Insulation of the electrical conductor shall not be damaged when cutting the duct.

Cable Markers. The location of underground conduits or cable-ducts shall be marked with cable markers. The marker shall be placed at all changes in direction, where the underground distribution circuit is split, and at a maximum of 400 ft intervals on straight runs. Cable markers shall be a slab of concrete 2 ft square by 4 in. thick, with the word "Cable" die impressed into the surface of the marker, a minimum depth of 3/8 in. with letters a minimum of 2 in. high arrows showing the direction of the cable shall be die impressed or saw cut a minimum depth of 3/8 in. into the marker surface.

Curing of the concrete shall be in accordance with 702.21. The cable marker shall have a smooth metal trowel finish without scaling.

Underground Through Conduit. The underground distribution circuit shall be protected by galvanized steel conduit when installed under pavement, in road shoulders, or elsewhere as shown on the plans or as directed.

Cable-duct. Cable-duct shall be pulled through the entire length of galvanized steel conduit if at all possible. If this is not possible, written authorization shall be obtained to permit the duct to be cut away and the conductors installed in the conduit with a minimum of 2 ft of duct extended into the conduit. Where so authorized, the plastic duct shall be terminated in the proper transition fitting attached to the end of the conduit and each conductor of the cable-duct assembly shall continue undamaged and uninterrupted through the galvanized steel conduit to the other end of the conduit where a transition to the cable-duct shall be used again and the cable-duct shall continue uninterrupted to the next designated splice point. All transitions from galvanized steel conduit to cable-duct shall be accomplished with the proper adapter. This adapter shall provide a durable, watertight transition that has a smooth uniform interior.

Cable Markers. Cable markers shall be in accordance with 807.07

In Conduit Risers. Cable-duct shall enter the bottom of the conduit riser with a sweeping radius bend and continue up the riser to within 3 in. of the top of the conduit riser. At this point the plastic duct shall be terminated and the conductors shall continue uninterrupted and undamaged into the service cabinet, underpass switchbox, or through the weatherhead with sufficient excess to make the required connections.

Through Conduit in Bridge Coping. Where a cable-duct underground distribution circuit is run through conduit installed in bridge coping, the duct shall be cut away and the conductors shall be installed in the conduit with at least 2 ft of duct extended into the conduit. The conductors, through this transition, shall be continuous between authorized splice points. Where more than one lighting standard is to be installed on the same side of the bridge structure and connected to the same distribution circuit, the cables pulled between these lighting standards shall be of the same type and size used in the cable-duct underground distribution circuit.

Aerial Cable. Aerial cable for overhead distribution circuits shall be supported and terminated as shown on the plans. The aerial cable shall have a sag of no more than 5 % of the distance between lighting poles except where slack spans are indicated on the plans. Aerial cables shall have a minimum vertical clearance of 18 ft.

Lighting Handholes. Handholes shall not be placed in areas subject to flowing or ponding water. Handholes shall be installed with the top flush with adjoining surfaces. Precast handholes with integral bottoms will be considered acceptable.

Multiple compression fittings and insulating links installed in handholes shall be taped and waterproofed by application of an approved waterproofing device. The insulation around the area to be waterproofed shall be cleaned before applying the waterproofing device. These waterproofing devices shall be designed for insulating multi-conductor cables with a minimum voltage carrying capacity of 600 volts.

Heavy weave fiberglass reinforced polymer concrete service boxes will be permitted as an acceptable substitute for a street and alley handhole providing that they can be placed at a location which meets both of the following conditions:

- 1) there is no evidence of vehicles traveling over the area where the handhole is to be located

- 2) it is located a minimum of 15 ft from the edge of pavement, unless it is protected guardrail, unmountable curb, a structure, or an untraversable ditch.

The handhole shall be backfilled with sand or earth containing no particles that would be retained on a 1/4 in. sieve. The backfill shall be placed as shown on the detail sheet of the plans. No additional payment will be allowed for this backfill.

Concrete Foundations For Lighting Standards. Foundations shall be class A concrete in accordance with 702. Footings may be either round or square in shape as shown on the plans.

Anchor bolt circle dimensions shall be furnished and the anchor bolts shall be in accordance with 913.11(a)7. A rigid template shall be used to center the anchor bolts in the foundation. Unless otherwise specified, the template shall be oriented so that the mast arm of the lighting standard is perpendicular to the centerline of the roadway.

Each foundation installation shall have provisions for grounding the lighting standard in accordance with 807.12. The tops of the concrete foundations shall be constructed level and only shims used to rake the lighting standard will be permitted. Shims will not be permitted with break-away couplings. Each foundation shall have an imprinted arrow or arrows on the top of the foundation to indicate the direction of the cable duct run.

Foundations for high mast towers shall be constructed prior to constructing foundations for conventional roadway lighting.

Cast-in-Place Foundations. If the sidewalls of the excavated areas remain firm and stable, concrete may be poured directly against the dirt below the level of the top 6 in. form. Otherwise, the concrete foundation shall be fully formed by means of a paper preformed liner or other approved means. However, the foundation shall be formed to the proper size for the top 6 in. before concrete is poured. If a paper liner is used, it may be withdrawn as the concrete is placed or it may be left in place permanently. If the liner is left in place, all voids between the excavation walls and the form shall be filled and compacted using size No.53 aggregate. If the liner is withdrawn, the top 12 in. of the foundation shall remain formed until the concrete has obtained initial set.

Precast Foundations. Precast foundations shall be complete with reinforcing bars, tie bars, anchor bolts, and entry sleeves located to provide a level mounting for the lighting standard after installation. The grounding coil, as shown on the plans, may be used for grounding lighting standards set on precast foundations. Foundation backfill shall consist of compacted size No.53 aggregate.

Grading of Foundations. Foundation projection above the finished grade shall be as shown on the plans. The excavated material may be used for this grading if it is not granular in nature and will readily stabilize and support the growth of sod. If the excavated material is unsuitable, it shall be properly disposed

of and approved materials used. The area shall be sodded. Sodding will be in accordance with 621.

Placing Lighting Standards

Lighting Standards Under 80 ft in Height. The lighting standard assembly shall consist of a metal pole, a shoe base, a frangible breakaway base or coupling where shown on the plans, and a metal mast arm for attaching the luminaire. The unit shall be assembled on the ground. Pole circuit wiring shall be installed and the luminaire shall be attached prior to erection. The factory finish of the pole assembly shall be protected from marks, blemishes, scratches, or other damage. Slings and chokers for lifting purposes shall be of nylon or other approved material. Chains, metal rope, or other abrasive materials will not be permitted for lifting devices. If damage to the factory finish occurs, repair or replacement shall be as directed.

The base plate shall be designed to carry the pole assembly. The plate assembly shall be supported by a transformer base, which shall be in accordance with the breakaway requirements in the AASHTO Standard Specifications for Structure Supports for Highway Signs, Luminaries, and Traffic Signals.

After erection and attachment to the foundation, the pole assembly shall be plumb. The luminaires shall be level in both horizontal areas. Shims will not be permitted with breakaway couplings. Shimming will be permitted on other types of installations to rake the pole assembly to obtain the desired attitude of the luminaire where the combined weight of the pole and mast arm requires it and the luminaire saddle will not permit the adjustment. The mast arm shall be perpendicular to the axis of roadway travel unless special orientation is noted on the plans. Unless otherwise specified, the lighting system shall consist of metal pole supports for the luminaires with an underground electrical supply system.

High Mast Lighting Standards of 80 ft Height and Over. High mast light pole sections shall be mechanically fitted in the field using factory supplied hydraulic jack or hoist puller that shall produce a minimum force of 10,000 lb per side. Field assembly procedures and assembly apparatus requirements shall be submitted for approval. Field welds will not be permitted except where shipping limitations prevent permanent factory assembly. Prior approval for field welds is required.

The pole shall be erected on the lower set of the anchor bolt nuts and secured with the top nuts. The adjustments to plumb the pole shall be made prior to the final tightening of the top nuts.

The pole shall be plumbed under no wind conditions before sunup, after sundown, or on an overcast day. The deviation from vertical shall not exceed 1/4 in. within any 10 ft of height.

When installing the high mast power cable, one end of the power cable shall be securely connected to the luminaire ring. The other end of the power cable shall be secured to the support and terminated 3 ft below this support with a heavy duty three wire electrical plug. Adjustments of the three support cable lengths shall be made prior to lowering the ring for the first time. After the support cables have been adjusted and the luminaires installed on the ring, at least one complete cycle operation of the ring shall be conducted on each structure.

Grounding. Ground wire shall be No. 6 solid bare copper. Ground rods shall be 1/2 in. diameter by 8 ft long copper-weld ground electrodes except where larger sizes are specified. The top of the ground rod shall be driven at least 6 in. below grade. Ground rods shall not be installed within the lighting standard, sign structure, or high mast tower foundations.

The ground wire shall be connected to the top or side of the ground rod. The ground rod, ground wire connection shall be made by a thermo weld process. The wire and ground rod shall be free of oxidized materials, moisture, and other contaminants prior to inserting the wire and the ground rod into the properly sized mold. The welding material shall sufficiently cover and secure the conductor to the rod. The completed connection shall be nonporous.

As an acceptable substitute to this process, a mechanical ground grid connection of an approved type may be used. Tap type clamps, parallel type clamps, U-bolt flat clamps, and crossover clamps will not be accepted.

Luminaire standards shall be grounded by connecting the free end of the ground wire to the grounding lug in the transformer base or pole. The free end of the ground wire shall enter the pole base through the entry sleeve installed in the foundation.

The neutral conductor of the underground distribution circuit shall be connected to the ground lug in the transformer base or pole. This connection shall include a quick-disconnect type connector kit so that in the event of a pole knockdown the connection will readily break without damage to the buried conductor .

The breaker boxes for the sign and underpass circuits shall be grounded by connecting the free end of the ground wire to the neutral grounding terminal in the breaker box and connecting this terminal to a grounding lug securely fastened to the metal interior of the breaker box. The conduit terminating in the breaker box and the sign or underpass luminaire housing shall have a good, clean, tight connection and act as a grounding conductor for these luminaires. The neutral conductors of the feed and distribution circuits for underpass and sign illumination shall be connected to the neutral grounding terminal in the switch box or breaker box. The neutral conductor of the distribution circuit for underpass and sign illumination shall be grounded in each luminaire by connecting a jumper from the neutral terminal of the luminaire to a ground lug fastened to the metal housing of the luminaire.

Sign structures shall be grounded at one sign column by connecting the free end of the grounding wire at that column to the grounding lug in the column base.

A type I service for supply of electrical energy shall consist of a conduit riser to a weatherhead. This conduit shall be grounded at the lower end by means of a standard strap grounding connection to the ground wire and ground rod. A type II service shall consist of a multiple number of conduits from underground to the bottom of the service cabinet and a single conduit to a weatherhead from the top of the service cabinet. All of these conduits shall be connected by a single ground wire from the grounding terminal to a grounding bushing for each conduit within the interior of the service cabinet. In addition a ground wire from the grounding terminal of the service cabinet shall be connected through a conduit to a ground rod.

Bridge railing conduits shall be grounded at each end of the bridge railing by means of a standard grounding strap connected to a ground wire and ground rod. The ends of the conduits terminating in a bridge anchor location shall provide ground continuity by means of a grounding bushing on each conduit end and the connection of the bushing to a ground wire.

All equipment used in the highway lighting system shall be grounded. If necessary, additional grounding shall be installed as directed.

Luminaire Installation. Luminaire installation shall consist of the physical placing of the luminaire. Each installation shall include the furnishing and placing of the lamp as designated.

Roadway Luminaires. Each luminaire shall be leveled in both directions in the horizontal plane after the light standard has been erected and adjusted. Rotary adjustment of the mast arm and vertical adjustment of roadway luminaires to obtain an installed level position in both directions shall be accomplished by means of the bolted saddle arrangement used to attach the luminaires to the mast arm. Lamp socket positions may be shown on the plans by type of Illuminating Engineering Society of North American (IES) light pattern. The specified lamp socket position shall be used to obtain the desired light pattern delivery. Proper connections shall be made to provide ballast operation at the voltage being supplied. Replacements needed because of faulty or incorrect voltage connections shall be made with no additional payment.

Sign Luminaires. Connections in which plain and galvanized steel are in contact shall be protected such that aluminum surfaces shall receive one coat of zinc chromate primer. Steel surfaces shall receive one coat of inorganic zinc primer followed by one coat of aluminum paint. All paint shall be permitted to dry before assembly. Conduit fittings, if required, shall be watertight. Required conduit shall be either rigid or flexible as necessary. Conduit shall not be clamped to a sign panel.



Sign luminaires shall be mounted on overhead sign structures on two metal channels located at the extremity of the sign walkway support brackets. The distance between lighting unit support channels shall be 7 in. These channels shall be located in such a manner that they readily receive the mounting bolts from the rear of the sign luminaire. The installation of the sign luminaire shall consist of the physical placement of the luminaire on the channels.

Sign luminaires shall be connected to a phase conductor and a neutral conductor. The luminaires shall be alternately connected to opposite phase conductors to balance the load. The connections in the base of the sign structure shall be in accordance with 807.06. Conductor splicing shall be in junction boxes, in-ground handholes, inside handholes of sign structures, and circuit breaker enclosures.

Underpass Luminaires. Underpass luminaires shall be mounted on the vertical side surfaces of bridge bent structures or suspended by means of pendants supported by angle-iron struts or clips fastened to the structural beam members of the bridge. All parts of the pendant pipe assembly shall be hot-dipped galvanized after threads are cut. Silicone caulking compound shall be applied to the threads during assembly of the pendant. Underpass luminaires may require separately mounted ballasts, which shall be installed in close proximity to the luminaires.

Underpass luminaires shall be connected to a phase conductor and a neutral conductor. The luminaires shall be alternately connected to opposite phase conductors to balance the load. Conductor splicing will only be allowed in junction boxes, in ground handholes, and circuit breaker enclosures.

High Mast Luminaires. The aiming of the luminaires shall be as shown on the plans. When the aiming process is being done the luminaire shall be oriented to conform to its raised position and the ring properly tethered to prevent rotation during the aiming adjustment. The long axis of the luminaire shall be parallel to the aiming direction indicated on the plans.

Sign, Underpass, Roadway, and High Mast Lighting Location Identification. All high mast towers, roadway light standards, underpass lighting installations, and sign lighting installations shall have an identification code number as shown on the plans. In addition, each luminaire at a sign or underpass installation shall be individually identified with a single capital letter.

The code number shall be displayed on the light standard, sign structure column, and high mast tower as shown on the plans. The underpass code number shall be displayed near the breaker box at a location as directed.

The code number for the lighting standard and sign structure column shall be applied to the pole, as specified by the manufacturer, by using individual, pressure sensitive, adhesive backed tags. The code number for the high mast tower shall be applied to an aluminum plate, which is mounted with spacers away from the structure as shown on the plans.

Service Point Power Entry. The utility's requirements for service locations shall be coordinated. Unless otherwise specified, a pole shall be furnished for the service point. If the utility requires metering of the lighting system, a meter socket shall be obtained from and installed in accordance with the requirements of the utility. Grounding shall be in accordance with 807.11 and shall be a part of the service installation.

Energy shall be provided with 120/240 V service or 240/480 V service with the proper KW capacity on poles located immediately inside the right-of-way at locations designated on the plans. Electrical materials incorporated in the work shall be compatible with the service voltages supplied by the local utility.

The service voltages supplied by the local utility shall be checked for compliance with the planned voltages. If a discrepancy exists, it will be resolved as directed before work is started or any electrical equipment is purchased.

Types of Service Points. Service point installations shall be of two types as shown on the plans.

1) **Type I Service Point.** This service point installation shall consist of class 5 wood pole, 2.75 in. galvanized steel conduits, weatherhead, photo cell and multiple relay switch. The conduit riser shall be fastened and supported on the pole by means of galvanized hook pipe straps and secured to the pole by means of a galvanized lag screw all of the proper size for the conduit being installed. Cable-duct shall be installed in the conduit riser in accordance with 807.07. The conductors shall extend beyond the weatherhead a minimum of 4 ft. The conductors outside of the weatherhead shall be ringed to prevent moisture from entering the conduit enclosure.

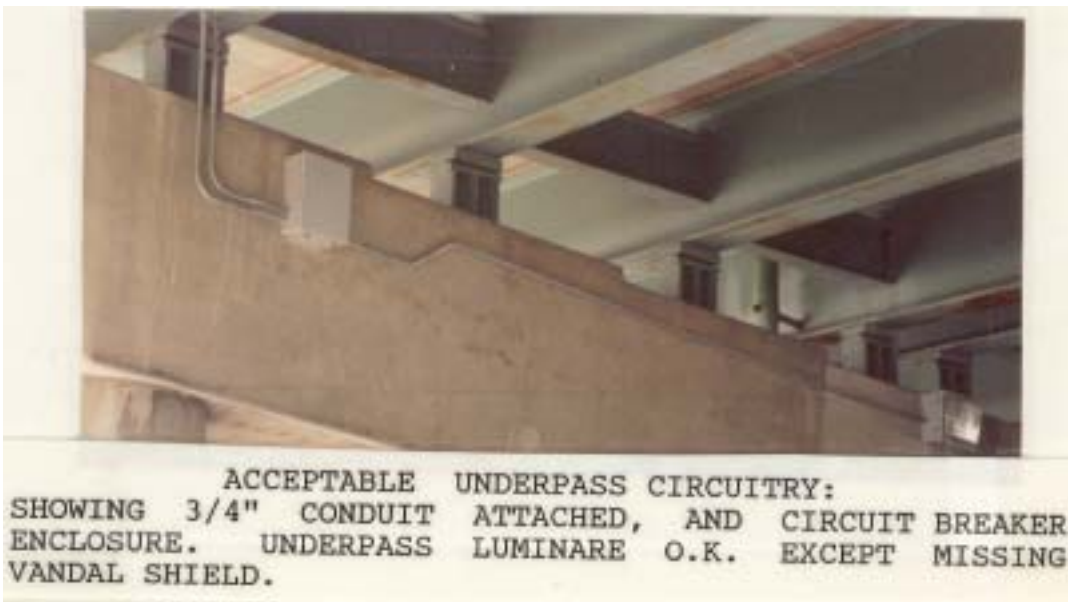
2) **Type II Service Point.** This service point installation shall consist of a service cabinet with a single galvanized steel or aluminum conduit riser to the weatherhead. A multiple number of galvanized steel conduits shall extend from the bottom of the service cabinet in accordance with 807.05. Underground cable-duct shall be installed in accordance with 807.07(c). Connections, connectors, and fixtures shall be as shown on the plans.

The service cabinet shall be secured to the pole by means of a galvanized steel channel post or other approved device.

Sign and Underpass Circuits. The illumination circuits for sign structures with an overhead power supply shall be protected by circuit breakers mounted on the end support.

Circuits for adjustable end support sign structures, bridge bracket signs, or underpasses shall be protected by circuit breakers mounted on the bridge or sign structure and connected to the underground distribution circuit in a handhole.





Circuits for sign structures with an underground power supply shall be protected by fuse connector kits in the base of the sign support. The fuse connector kits shall include bayonet disconnect features for the "neutral" side and "hot" side.

Multiple Relay Switches. Unless otherwise specified, wood pole, multiple relay switches, service cabinet, photocells, photocell receptacles, weatherhead, conduit, and other miscellaneous items shall be furnished and installed as a part of the service point.

Testing of Highway Lighting System

Testing Lighting Circuitry. All necessary equipment and apparatus properly calibrated for testing the lighting circuits shall be furnished. The supplying utility shall be given advance notice of the test scheduling so their

representative may witness the testing procedures if desired. Each main lighting circuit, including its branches, shall be tested for insulation resistance and continuity after it is completely installed but before the pole circuits, underpass circuits, sign circuits, and grounding circuits are connected. The insulation resistance test shall be made with a megohm meter and the resistance to ground shall be no less than 50 megohms in all lighting circuit power cables. The meter shall be set for the voltage rating of the insulation. The continuity test shall be made with an ohmmeter properly scaled for measuring the resistance of the power cables. This test shall verify the following:

1. That each power cable is continuous to its termination points.
2. That the cable coding at junction and termination points is consistent with cable coding at the supply point.
3. That power cables are not crossed with the neutral or each other
4. That the main circuit through each of its branches does not have unusual resistance values.

The entire completed installation shall be tested by circuit or by such portions as may be selected and at night if directed. Tests shall demonstrate the following:

1. That all power, lighting, and control circuits are continuous, free from short circuits, and free from unspecified grounds.
2. That all circuits are properly connected in accordance with applicable wiring diagrams.
3. That all circuits are operable which shall be demonstrated by continuous operation of each lighting circuit for at least 1 h.
4. That voltage at the ends of each lighting circuit and at inter points is within allowable limits. A maximum of 10% voltage drop will be permitted for each complete circuit.

Testing and Inspecting Luminaires. The lighting system from the service point through the last luminaire shall be subjected to 14 days of normal operation prior to final acceptance. This testing procedure may be conducted separately on each circuit or on the entire system.

Normal operation is defined as the luminaires being on during the darkness hours and off during the daylight hours as controlled by the service point photocells and relay switches. Malfunctioning equipment shall be replaced or repaired before final inspection. The pattern of light delivered to the pavement by roadway and high mast luminaires will be inspected at night. At this inspection, the proper tools, equipment, and personnel shall be available

to make all adjustments. These items shall specifically include a bucket truck capable of reaching all luminaires in the system, safety equipment, and a level to determine the proper luminaire position.

Pay Item and Installation Summary Sheets. Prior to final inspection, two sets each of shop drawings, installation summary, and pay item summary marked Final Record shall be furnished for the light standards as installed. The installation summary shall show the effective mounting height, arm length, foundation elevation, pay item, type of base, and catalog number or drawing for each light standard furnished. The pay item summary shall indicate the pay item, quantity, effective mounting height, arm length, and type of base for each type of lighting standard furnished.

Method of Measurement. Luminaire, light standard with mast arm, high mast standard, identification number, connector kit, multiple compression fitting, insulating link, foundation, handhole, service point, and cable marker will be measured by the number of units installed. Pole circuit conductor and circuit conductor in conduit will be measured by the linear foot. Pole circuit conductor will be measured from the base of the lighting standard to the terminal block of the luminaire. Pole line extension will be measured in a straight line between each pole.

Conductor in bridge conduit will be measured by the linear foot from end to end of conduit or from the end of conduit to the last bridge light pole foundation entry. An allowance of 5 lft will be made for each foundation entry. An allowance of 2 lft will be made for each junction box.

Removal of existing light structure, which shall include the pole, mast arm, and foundation, will be measured by the number of units removed.

Cable-duct and conductor in underground duct or conduit will be measured by the linear foot as follows:

From the Face of the Concrete Foundation to the Center of the Handhole or Face of the Next Concrete Foundation. An allowance of 5 lft will be made for each entry at foundations. An allowance of 2 lft will be made at handholes for connection purposes.

From Lighting Standard Bases or Handholes to Switch Boxes at Underpasses. An allowance of 4 lft will be made at the switch box for electrical connections.

From End to End of the Conduit when the Cable is in Conduit Under a Roadway Surface or Shoulder. No measurement will be made of cable-duct in conduit where it is part of a service point, sign installation, or Underpass lighting system.

Basis of Payment. Luminaire will be paid for at the contract unit price per each for the type and wattage specified. Service point will be paid for at the contract unit price per each for the type specified. Light pole will be paid

for at the contract unit price per each for the estimated mounting height, length of mast arm, and base type specified.

Lighting foundation, concrete, with grounding will be paid for at the contract unit price per each for the size specified. If class X material is encountered during lighting foundation excavation, payment will be made for such excavation in accordance with 206. Partial payment for lighting foundation in the amount of 80% will be made if all such work is complete except for finish grading and sodding. The remaining percentage of payment will be made upon completion of the finish grading and sodding.

Connector kit will be paid for at the contract unit price per each for fused or unfused, as specified. Multiple compression fitting and insulation link will be paid for at the contract unit price per each for waterproofed or nonwaterproofed, as specified.

Cable-duct marker, high mast tower winch drive, and handhole, lighting will be paid for at the contract unit price per each. Sign, underpass, and roadway lighting location identification will be paid for at the contract unit price per each. Circuit installation will be paid for at the contract unit price per each for the type, structure number, and number of luminaires specified. Light Structure, remove and portable tower lighting drive system will be paid for at the contract unit price per each.

Wire will be paid for at the contract unit price per linear foot for the designation, copper gage, housing, and number of conductors specified. Pole circuit cable, THWH, stranded will be paid for at the contract unit price per linear foot for the copper gage and number of conductors specified. Conduit, steel, galvanized, 2 in. diameter will be paid for at the contract unit price per foot.

The costs of lamps, ballast, optical systems, weatherproof housings, and electrical connections shall be included in the cost of luminaire.

The costs of the mast arm, J-support hook for pole circuit, handhole with cover, shoe base, transformer base or frangible coupling if required, installation on the foundation with the pole circuit, and luminaire installation shall be included in the cost of light pole.

The costs of the pole; lowering system including winch assembly, power cable, and support cable; concrete pad; luminaire ring; anchor bolts and nuts; lightning rod assembly; grounding system; and all incidental materials necessary to complete the installation shall be included in the cost of light pole, high mast. The costs of excavation, concrete, sleeves for cable duct, non-metal pipe, reinforcing steel, backfill, finish grading, and sodding shall be included in the cost of lighting foundation.

The costs of aerial distribution service, drops to sign structures branching off from the pole line extension, weatherheads and risers required to connect

the line extension to the underground electrical distribution circuit, all anchorage, guy wires, hardware, aerial cable, electrical connections, wood poles, and incidentals required to complete the pole line extension shall be included in the cost of cable, pole circuit.

The costs of snap-on covering in light pole base and waterproof covering in underground handhole shall be included in the cost of multiple compression fitting.

The costs of circuit breakers; breaker enclosures; conduit; flexible conduit; conduit fittings; grounding; weatherhead; aerial cable termination; and incidentals required from the last luminaire to the point of attachment by the utility, the bottom of the riser at the structure base, or the connector kits in the base of the sign supports shall be included in the cost of circuit installation.

The cost of maintaining highway illumination during the contract time shall be included in the costs of other pay items.